

Planning for an Uncertain Future

Improvements to analytical tools
allow the Water Plan to begin to
evaluate the performance of
resource management strategies
in light of many future risks and
uncertainties



Presentation Overview

- 💧 Vision for analytical tool improvements
- 💧 Review of Update 2009 characterization of the future (Scenarios)
- 💧 Stakeholder feedback
- 💧 Enhancements for Update 2013
- 💧 Goals for today



Vision & Purpose for Analytical Tool and Data Improvements

- 💧 Vision
- 💧 Update 2009
- 💧 Stakeholder feedback
- 💧 Update 2013 enhancements

- 💧 Support decision making in light of uncertainties
 - Promote collaborative decision making, Shared Vision Planning
- 💧 Support integrated water management regionally and statewide
 - Supply reliability, flood management, environmental restoration, water quality, economic efficiency, social equity

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Water Plan

Quantitative Deliverables

(Phased Approach)

- ◆ Accurately describe recent water management conditions (Water Portfolios)
- ◆ Develop multiple baseline future conditions (Scenarios)
- ◆ Identify alternative water management response packages (management strategies)
- ◆ Evaluate performance of strategies in terms of benefits, costs, and tradeoffs
- ◆ Evaluate interaction between local, regional, and statewide water management
- ◆ Support Water Planning Information Exchange

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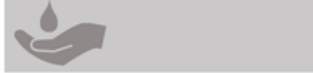
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Update 2009 Scenarios

- 💧 Vision
- 💧 Update 2009
- 💧 Stakeholder feedback
- 💧 Update 2013 Enhancements

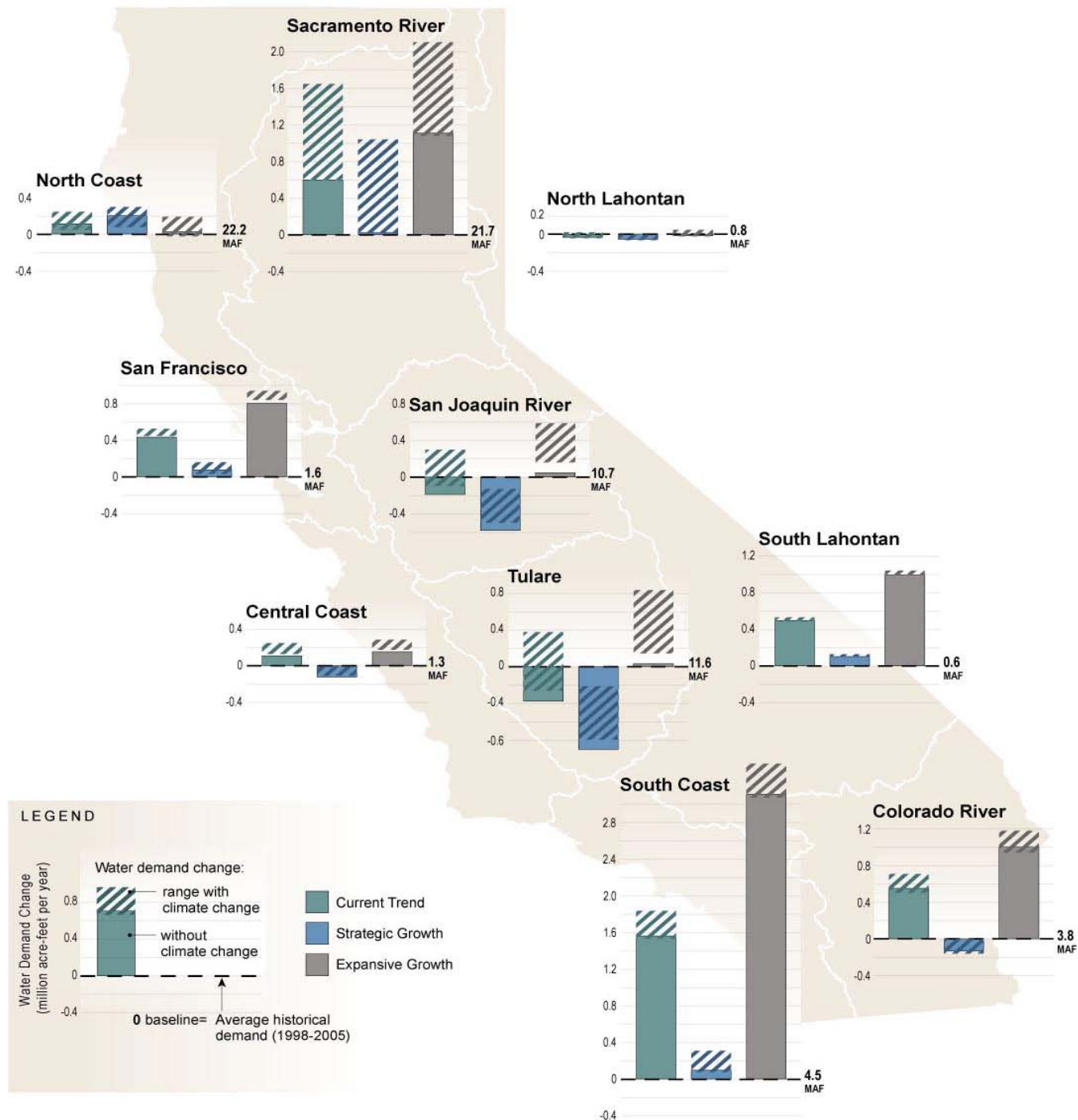
Factors of Uncertainty

	Current Trends	Slow & Strategic Growth	Expansive Growth
	Recent trends are assumed to continue into the future. Regulations are not coordinated or comprehensive, creating uncertainty for planners and managers. The state continues to face lawsuits, from flood damages to water quality and endangered species protections.	Private, public, and governmental institutions form alliances to provide for efficient planning and development that is less resource intensive than current conditions. State government implements comprehensive and coordinated regulatory programs to improve water quality, protect fish and wildlife, and protect communities from flooding.	Future conditions are more resource intensive than existing conditions. Protection of water quality and endangered species is driven mostly by lawsuits. State government has responded on a case-by-case basis, creating a patchwork of regulations and uncertainty for planners and water managers.
Population	 59.5 million* (22.8 million increase)	 44.2 million (7.5 million increase)	 69.8 million (33.1 million increase)
Land Use	 Continued development	 Compact development	 Sprawling development
Irrigated Crop Area	 8.6 million acres (0.7 mil. acre decrease)	 9.0 million acres (0.2 mil. acre decrease)	 8.2 million acres (1.0 mil. acre decrease)
Environmental Water	 1.0 additional MAF	 1.5 additional MAF	 0.6 additional MAF
Background Water Conservation	 10% more efficient	 15% more efficient	 5% more efficient

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Update 2009 Regional Water Demand Changes By Scenario



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Resource Management Strategies (Update 2009)

A Range of Choices

Reduce Water Demand

- ◆ Agricultural Water Use Efficiency
- ◆ Urban Water Use Efficiency

Improve Operational Efficiency & Transfers

- ◆ Conveyance – Delta
- ◆ Conveyance – Regional / Local
- ◆ System Reoperation
- ◆ Water Transfers

Increase Water Supply

- ◆ Conjunctive Management & Groundwater Storage
- ◆ Desalination –Brackish & Seawater
- ◆ Precipitation Enhancement
- ◆ Recycled Municipal Water
- ◆ Surface Storage – CALFED
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Improve Flood Management

- ◆ Flood Risk Management

Improve Water Quality

- ◆ Drinking Water Treatment & Distribution
- ◆ Groundwater / Aquifer Remediation
- ◆ Matching Quality to Use
- ◆ Pollution Prevention
- ◆ Salt & Salinity Management
- ◆ Urban Runoff Management

Practice Resource Stewardship

- ◆ Agricultural Lands Stewardship
- ◆ Economic Incentives
(Loans, Grants & Water Pricing)
- ◆ Ecosystem Restoration
- ◆ Forest Management
- ◆ Land Use Planning & Management
- ◆ Recharge Areas Protection
- ◆ Water-Dependent Recreation
- ◆ Watershed Management

Other-- Crop idling, dew vaporization, fog collection, irrigated land retirement, rainfed agriculture, waterbag transport

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Stakeholder Outreach

- 💧 Vision
- 💧 Update 2009
- 💧 Stakeholder feedback
- 💧 Update 2013 Enhancements

- 💧 SWAN Workshop – August 2010
 - Received advice on desired technical enhancements
- 💧 Advisory Committee – March 2011
- 💧 SWAN Workshop – May 2011
 - Shared results of Proof of Concept
- 💧 Focus group – June 2011
 - 2 meetings with a cross section of people that worked off-line to provide feedback
- 💧 June 29th Advisory Committee

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Stakeholder feedback

- ◆ Evaluate how factors like climate, future dedication of water to the environment, land use decisions and population interact to affect future water use
- ◆ Evaluate how resource management strategies perform under alternative plausible futures
 - Quantify costs, benefits, tradeoffs, and vulnerabilities



June 29th Advisory Committee

- ◆ Seeking shared understanding of :
 - The existing state (of water) in the regions
 - A range of multiple, plausible future conditions
 - What the options are to manage current and future conditions
 - The options that seem to make the most sense to invest in, in different regions



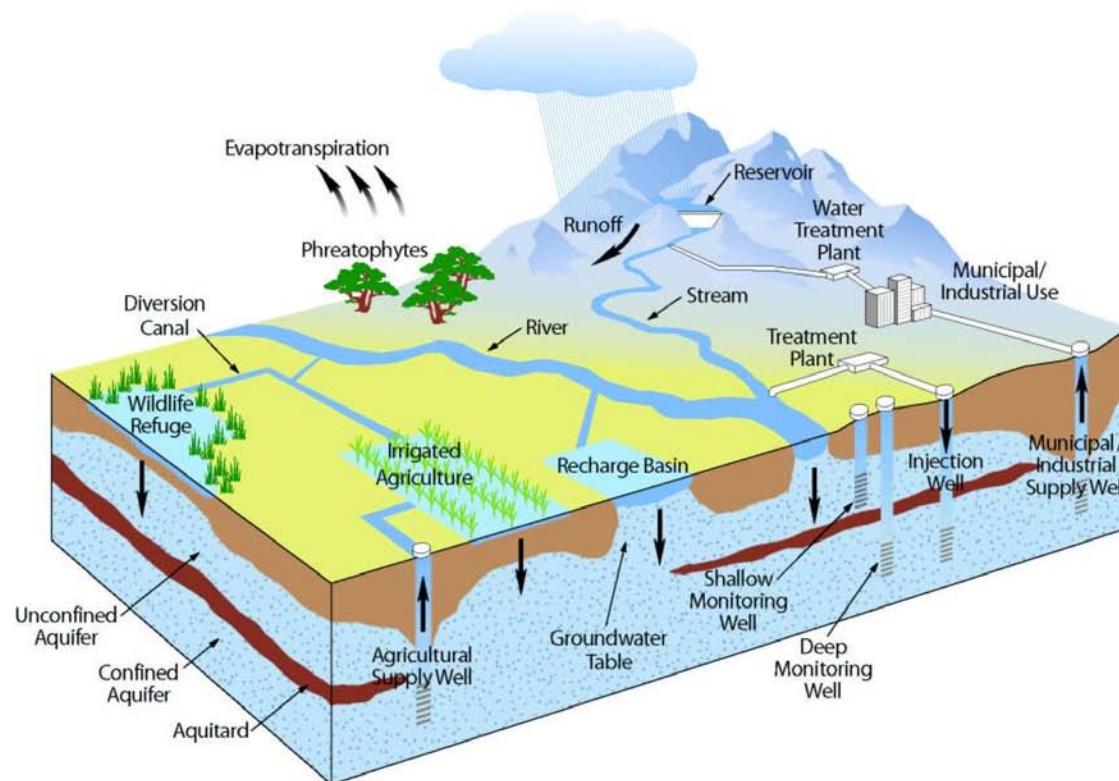
June 29th Advisory Committee

- 💧 AC asked to describe the 3 most important target audiences for the scenarios and response packages.
- 💧 AC asked to describe the policy questions the target audiences will want the Water Plan to answer via application of the scenarios



Improvements to analytical tools allow for more comprehensive evaluation

- 💧 Vision
- 💧 Update 2009
- 💧 Stakeholder feedback
- 💧 Update 2013 Enhancements

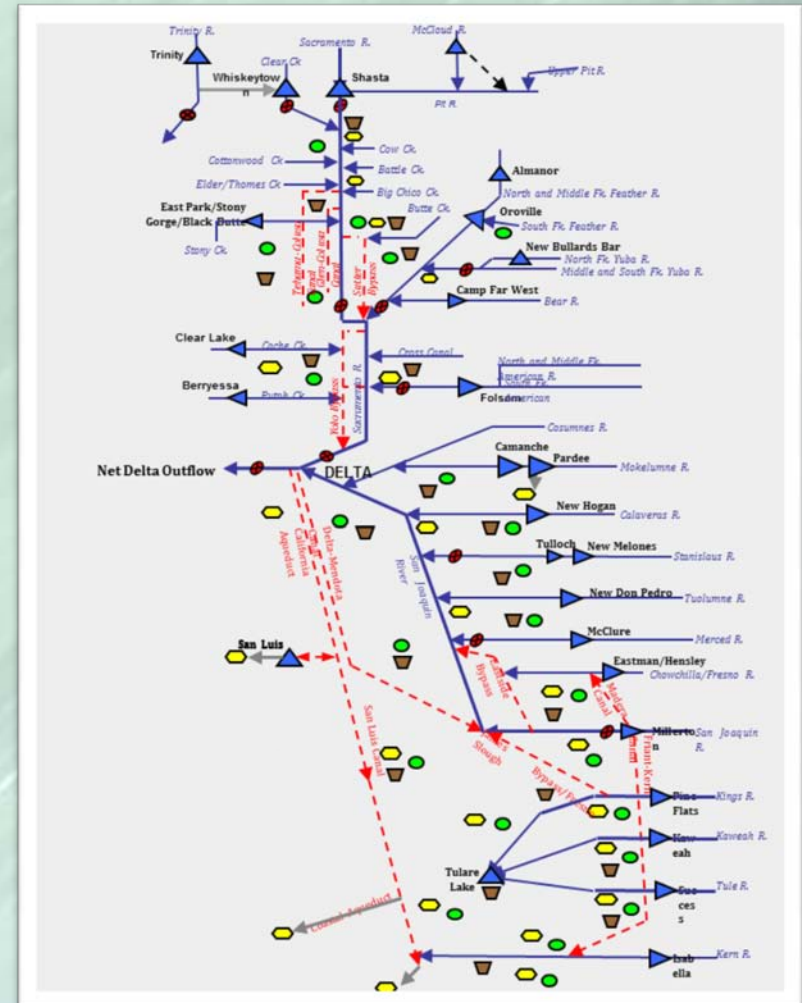


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Integrates Hydrology and Water Management

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Summary of analytical approach

- ◆ Apply an iterative, analytic approach that:
 - Considers *uncertainty* that is not easily characterized statistically
 - Future climate and population
 - Systematically evaluates *options* to increase robustness of current strategies
 - Analysis guides development of new, adaptive strategies
 - Quantifies outcomes across broad array of *performance measures*
 - Accommodates wide range of objectives and values over outcomes



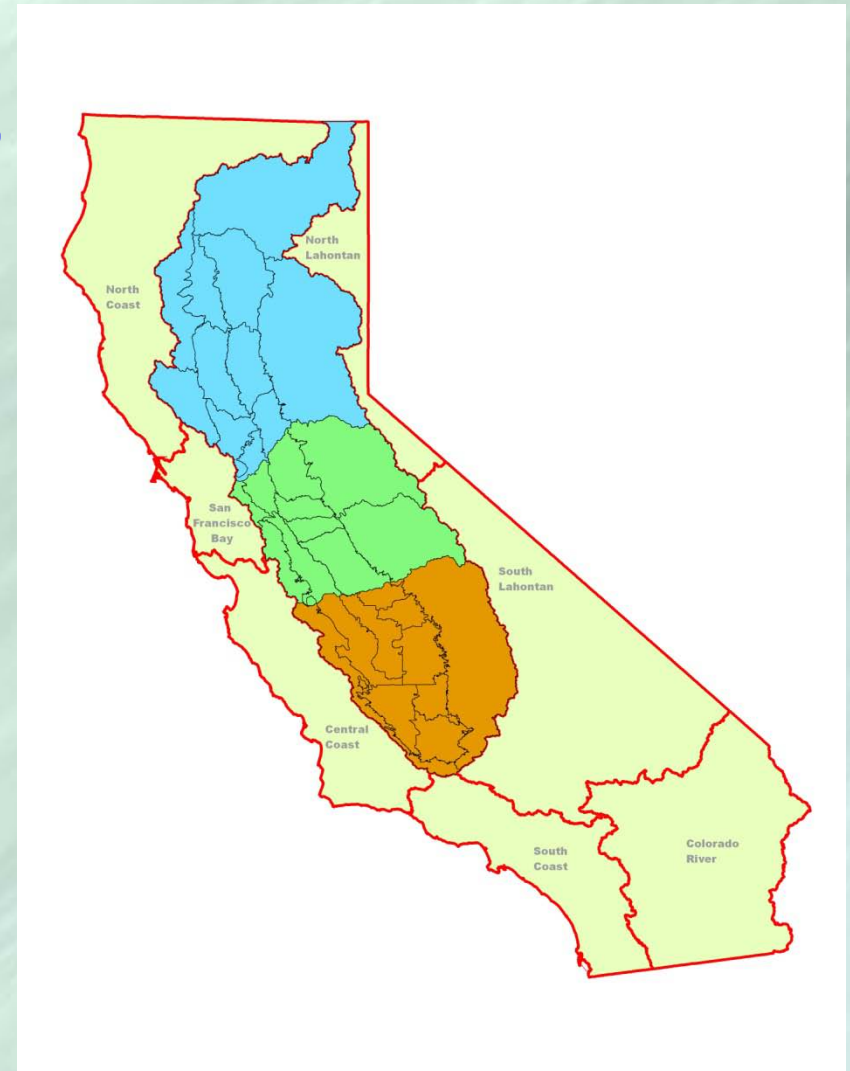
Putting it all Together

External Factors	Resource Management Strategies
<p>Population Climatic conditions</p>	<p>Strategies that:</p> <ul style="list-style-type: none"> •Reduce water demand •Improve operational flexibility & transfers •Increase water supply •Practice resource stewardship •Improve water quality •Improve flood management
Analytical Tools	Sample Performance Measures
<p>Water Evaluation and Planning (WEAP) model Planning Area scale for Central Valley Regions</p>	<p>Supply Reliability (Urban & Agriculture) Environmental flows Groundwater levels Strategy cost</p>



Limitations for Update 2013 Analysis

- Resource limitations restrict more comprehensive analysis to three regions in Central Valley
 - Phased approach
- Cannot represent all strategies or quantify all strategy benefits
- Coarse representation of regional groundwater and surface water systems
- Use monthly rainfall-runoff, water use, and water system operations data



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Areas Outside of Sacramento River, San Joaquin River and Tulare Lake Regions

- 💧 Apply simpler Hydrologic Region model developed for Update 2009
- 💧 Quantify regional water demand
 - Update 3 growth scenarios
 - Update 12 climate scenarios
- 💧 Ability to include some demand management strategies



Goals for Today

- 💧 Learn how two other planning efforts considered uncertainty (case studies)
- 💧 Solicit advice on policy linkages to RMS
- 💧 Solicit advice on policy linkages to evaluating RMS performance
- 💧 Solicit advice on policy linkages to key uncertainties like population and future climate



Case Studies



CWP Planning Approach Designed for Long-term Decision-making

- 💧 *The future is uncertain:* no single prediction of the future is adequate for planning
- 💧 *There is no silver bullet:* there are many options and important tradeoffs among them
- 💧 *Analysis can only inform policy decisions:* Analysis supports deliberation over tradeoffs

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Planning Approach Applied at the Regional and Local Scales in California

- 💧 *Inland Empire Utilities Agency: Preparing for an Uncertain Future* (NSF: 2006-2008)
- 💧 *Metropolitan Water District of Southern California: Developing signposts for the adaptation of its 2010 Integrated Resources Plan* (MWD: 2011-present)
- 💧 *El Dorado Irrigation District: Developing Robust Water Management Climate Change Adaptation Strategies in the Sierra Nevada* (CEC PIER: 2009-present)

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Research Study* Developed Methodology to Identify Water Management Strategies Robust to the Uncertain Future

How should the Inland Empire Utilities Agency augment its Urban Water Management Plan to prepare for climate change?

1. **Evaluated UWMP under many future scenarios**
2. **Identified key vulnerabilities of the UWMP**
3. **Analyzed additional strategies that could mitigate these vulnerabilities**
4. **Explored key tradeoffs among strategies**



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Funding provided by the National Science Foundation

Research Team Worked Collaboratively with Water Managers and Stakeholders

💧 Held four workshops

- Discussed future challenges, potential adaptations, and performance metrics
- Presented and evaluated different approaches for incorporating uncertainty
 - Simple scenarios
 - Probabilistic assessment
 - Robust decision methods

💧 Developed WEAP model of IEUA system

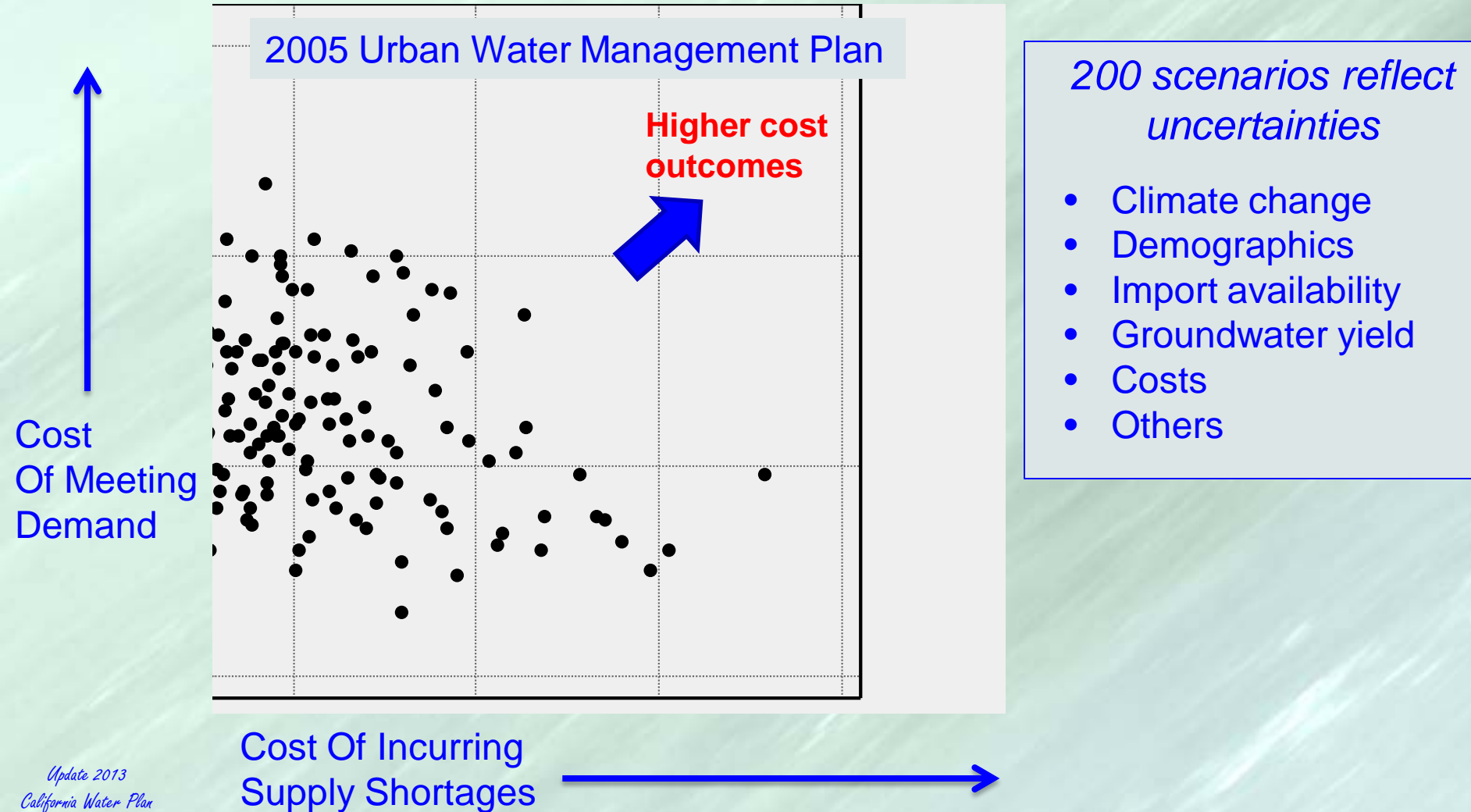
💧 Documented analysis and workshops in two reports

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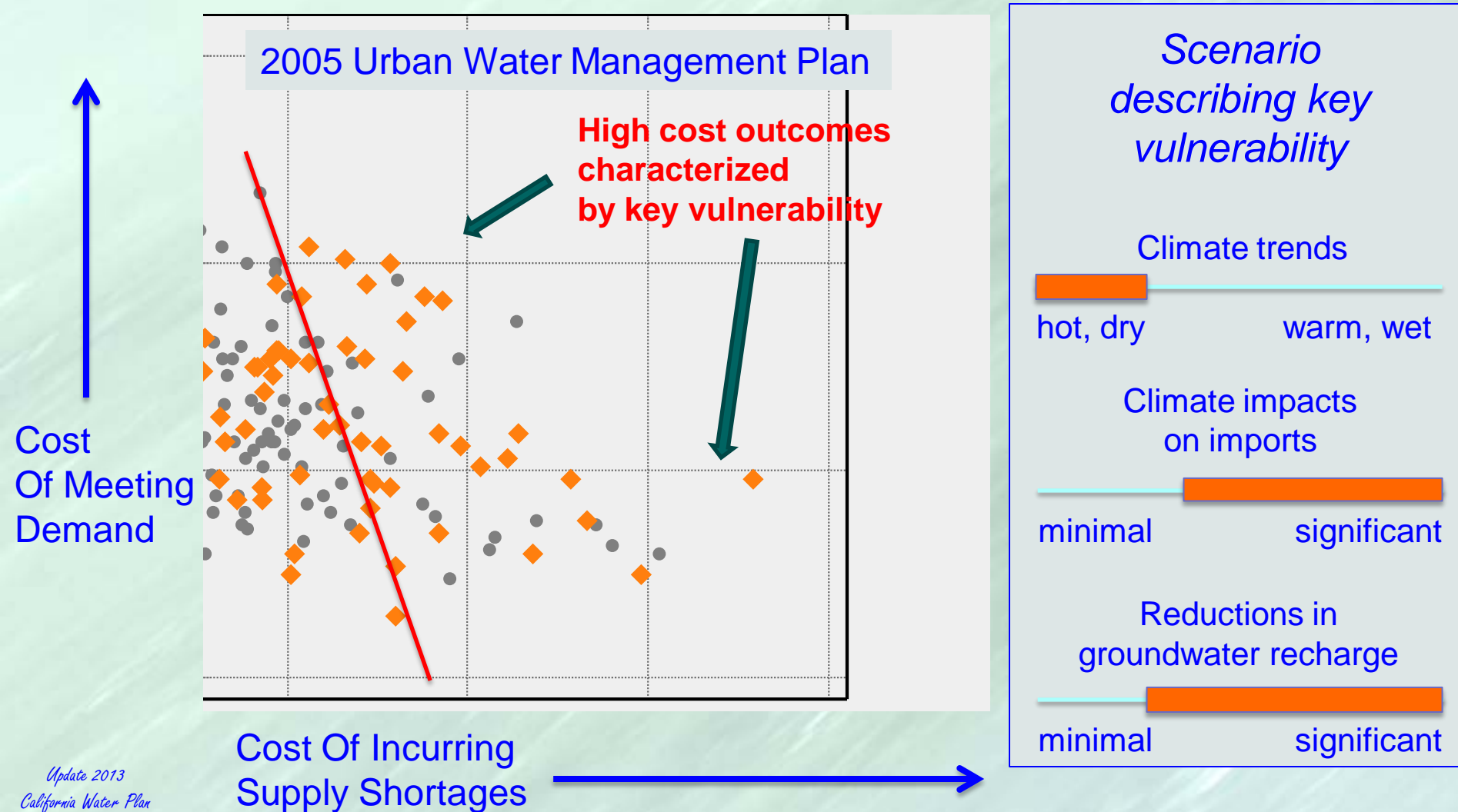
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1) Performance of Current Plan Would Vary Widely Under Plausible Scenarios



2) Plan Was Vulnerable to Warm and Dry Climates; Declines in Groundwater Recharge and Import Availability



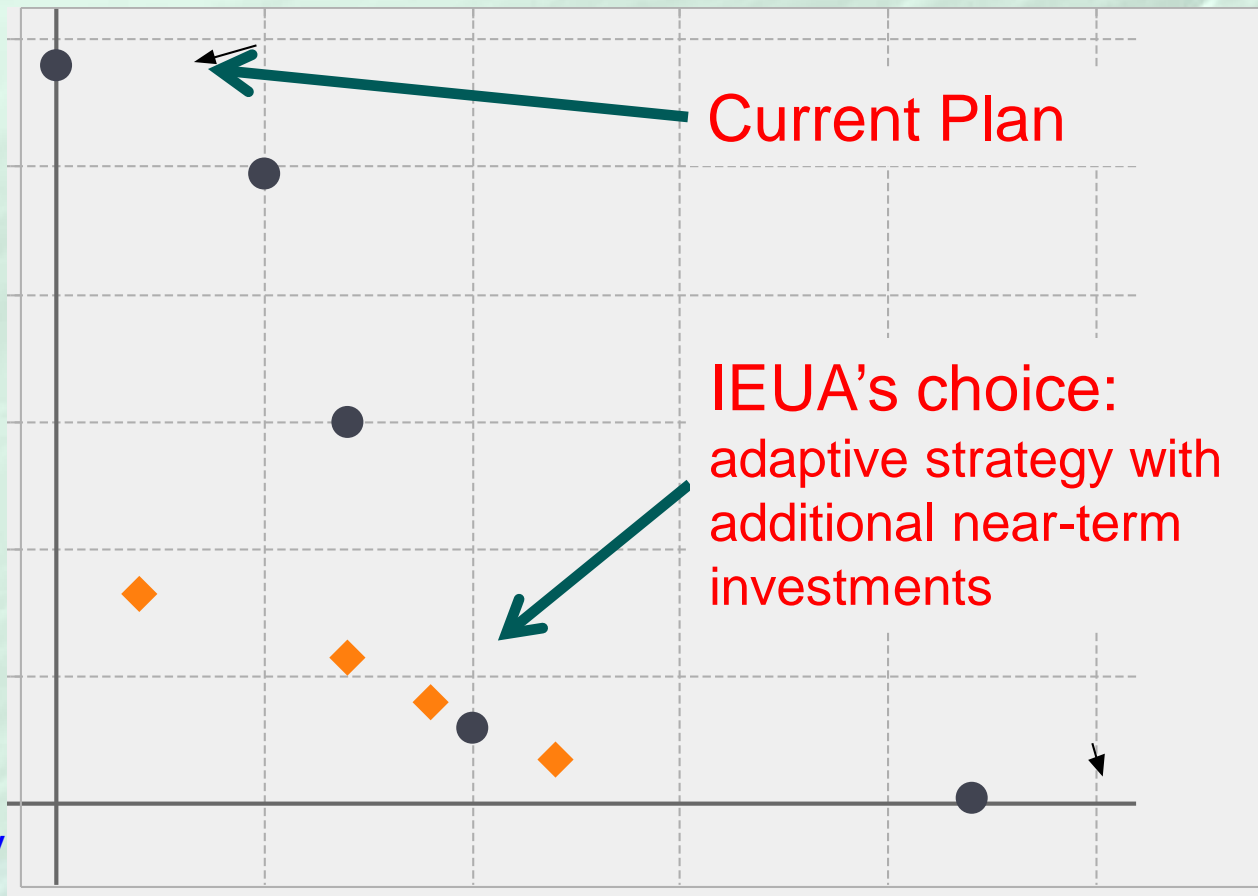
3) Evaluated Additional Resource Management Strategies To Mitigate Key Vulnerability

- 💧 Increased efficiency
 - 💧 Accelerated groundwater banking
 - 💧 Accelerated water recycling
 - 💧 Stormwater capture and banking
-
- 💧 “Adaptive strategies” that increase investment only when needed



4) Additional Strategies Would Reduce High-Cost Outcomes at Additional Effort

Number of
Scenarios
in Which
Performance
Of Plan is
Unsatisfactory



Additional Effort
Required to
Implement Plan

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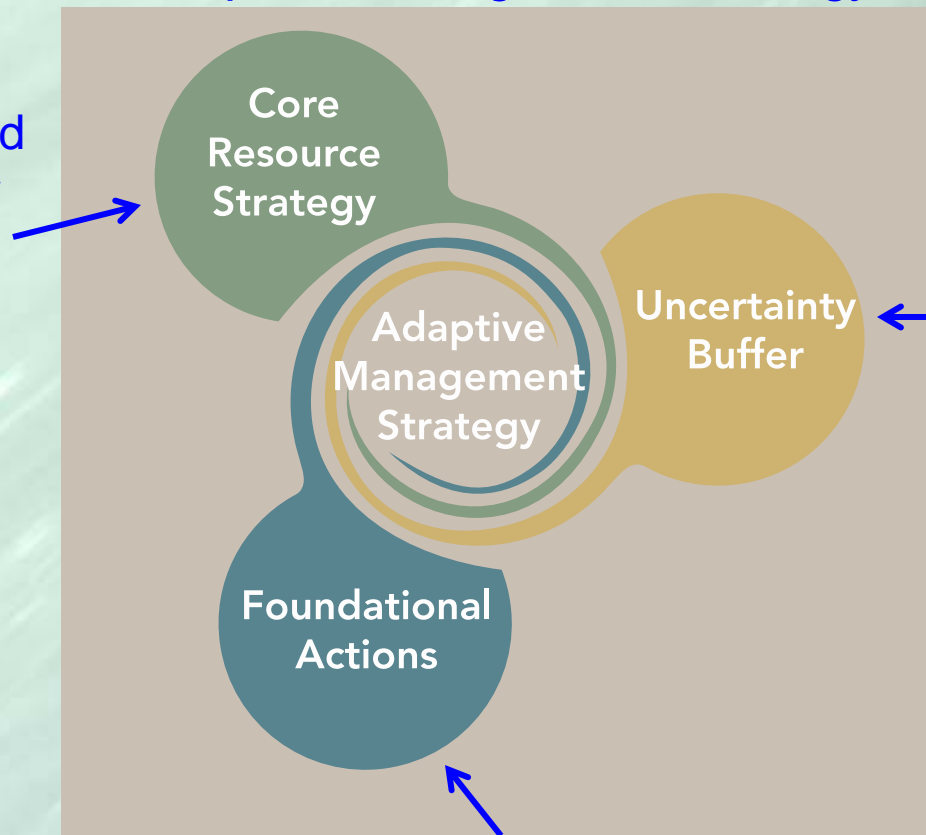
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Another Example: Developing an Adaptive Integrated Resource Plan for Metropolitan Water District*

Metropolitan's Three-Component Adaptive Management Strategy

Strategies designed to ensure reliability under anticipated future conditions



Additional strategies to accommodate uncertainty, implemented as needed

Preparation for future investments if needed

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Metropolitan is Refining its Planning Approach to Define an Adaptive IRP

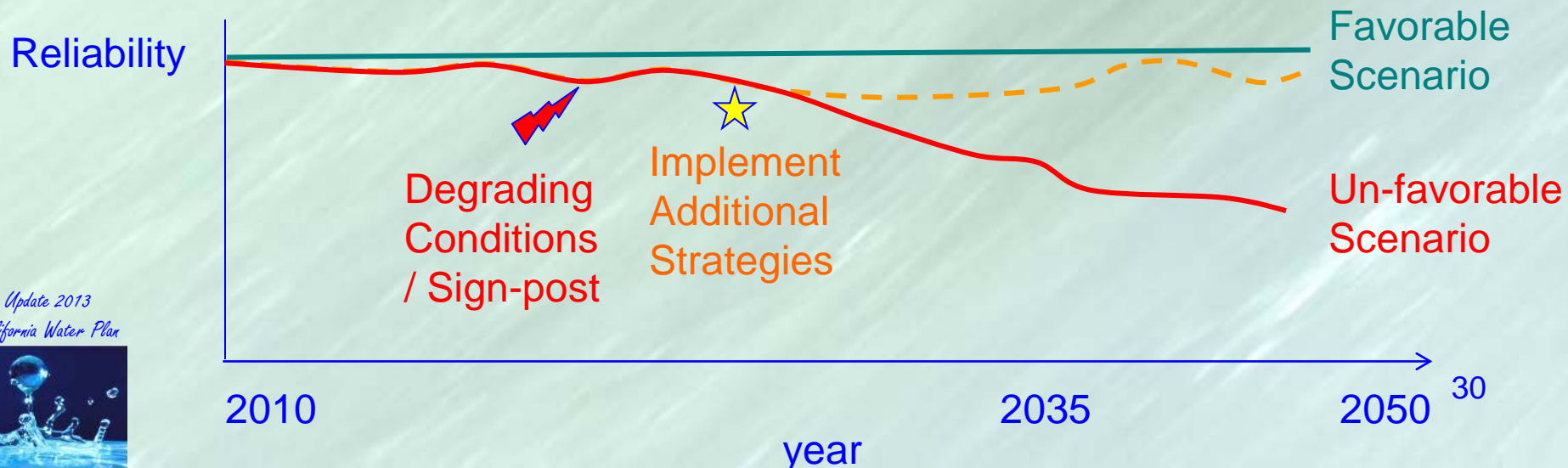
- ◆ Evaluating Core Resource Strategy under many scenarios
 - Climate change (12 scenarios)
 - Member agency water demand (4 scenarios)
 - Local resource yields (~100)
 - Implementation timing of IRP projects (various)
- ◆ Key performance measures identify vulnerabilities
 - Reliability
 - System performance
- ◆ Characterizing vulnerabilities helps define signposts and additional strategies for adaptation



Signposts Trigger Additional Implementation

💧 Analysis answering key questions:

- What specific conditions would the baseline IRP under perform?
- What should Metropolitan monitor to trigger additional investment needs?
 - Climate, demographic trends ; other supply conditions



Questions on Case Studies?



How Should We Implement this Approach for the Update 2013?

- 💧 Which resource management strategies should we consider?
- 💧 What performance measures should we use to evaluate the effects of the strategies?
- 💧 Which future uncertainties are important and how many scenarios?

Spring 2011 Proof-of-Concept analysis (presented to SWAN) provides a demonstration and starting point for answering these questions



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Update 2013 Will Evaluate and Compare Resource Management Strategies

- 💧 Wide range of resource management strategies available
- 💧 Many strategies can be implemented in different locations, at different times, and to different extents
- 💧 Interactions among strategies can be important
- 💧 Response packages describe groups of strategies for comparison

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Resource Management Strategies (Update 2009)

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Other-- Crop idling, dew vaporization, fog collection, irrigated land retirement, rainfed agriculture, waterbag transport

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Only Some of These Strategies Can Be Modeled With Available Tools

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Other-- **Crop idling**, dew vaporization, fog collection, irrigated land retirement, rainfed agriculture, **waterbag transport**



Proof-of-Concept Analysis Grouped Some Strategies into Response Packages

← Strategies →

Response Package	Urban Water Use Efficiency	Agricultural Water Use Efficiency	Groundwater Recharge	Recycled Water Use
Baseline (#1)	O (current)	O	O	O
#2	+	O	O	+
#3	+	O	+	++
#4	++	+	O	+
#5	++	+	+	++
#6	++	+	+++	+++
#7	+++	+++	+++	+++



Discussion Questions

- ◆ What is your top five list of resource management strategies to be quantitatively evaluated for Update 2013?
- ◆ Are there thematic ways to group resource management strategies into response packages that make sense from a statewide policy perspective?
- ◆ Which land use strategies affecting density and distribution should Update 2013 consider in the response packages and what would they look like?
- ◆ How many different levels of environmental water (for instream flows and habitat restoration beyond existing requirements) should we consider in Update 2013; and what levels?



How Should We Implement this Approach for the Update 2013?

- 💧 Which resource management strategies should we consider?
- 💧 What performance measures should we use to evaluate the effects of the strategies?
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Performance Measures Summarize the Effects of Different Response Packages

Measures should relate to Update 2013 Objectives

- 💧 Water Supply & Supply Reliability
- 💧 Energy Benefits
- 💧 Flood Impact Reduction
- 💧 Food Security
- 💧 Groundwater Overdraft Reduction
- 💧 Environmental Benefits
- 💧 Drought Preparedness
- 💧 Water Quality
- 💧 Operational Flexibility and Efficiency
- 💧 Recreational Opportunity

Models and available data may limit which measures can be used



Proof-of-Concept Considered

Four Key Performance Measures



💧 Urban water supply reliability

- % of years in which at least 99% of demand is met



💧 Agricultural water supply reliability

- % of years in which at least 95% of agricultural demand is met



💧 Environmental performance

- % of months in which all In-stream Flow Requirements (IFRs) are met



💧 Cost of implementing strategies

- Notional cost estimates

Performance measures calculated at the Planning Area and Hydrologic Region scales

Discussion Questions

- ◆ Which performance measures are essential to make investment decision about different resource management strategies?
- ◆ Which temporal scales (daily, monthly, annual, etc.) and planning horizon (2020, 2050, 2100) are most useful to your decisions about investing in resource management strategies?
- ◆ Which spatial scales (water district, IRWM region, hydrologic region, tribal, statewide) are most useful to your decisions about investing in resource management strategies?



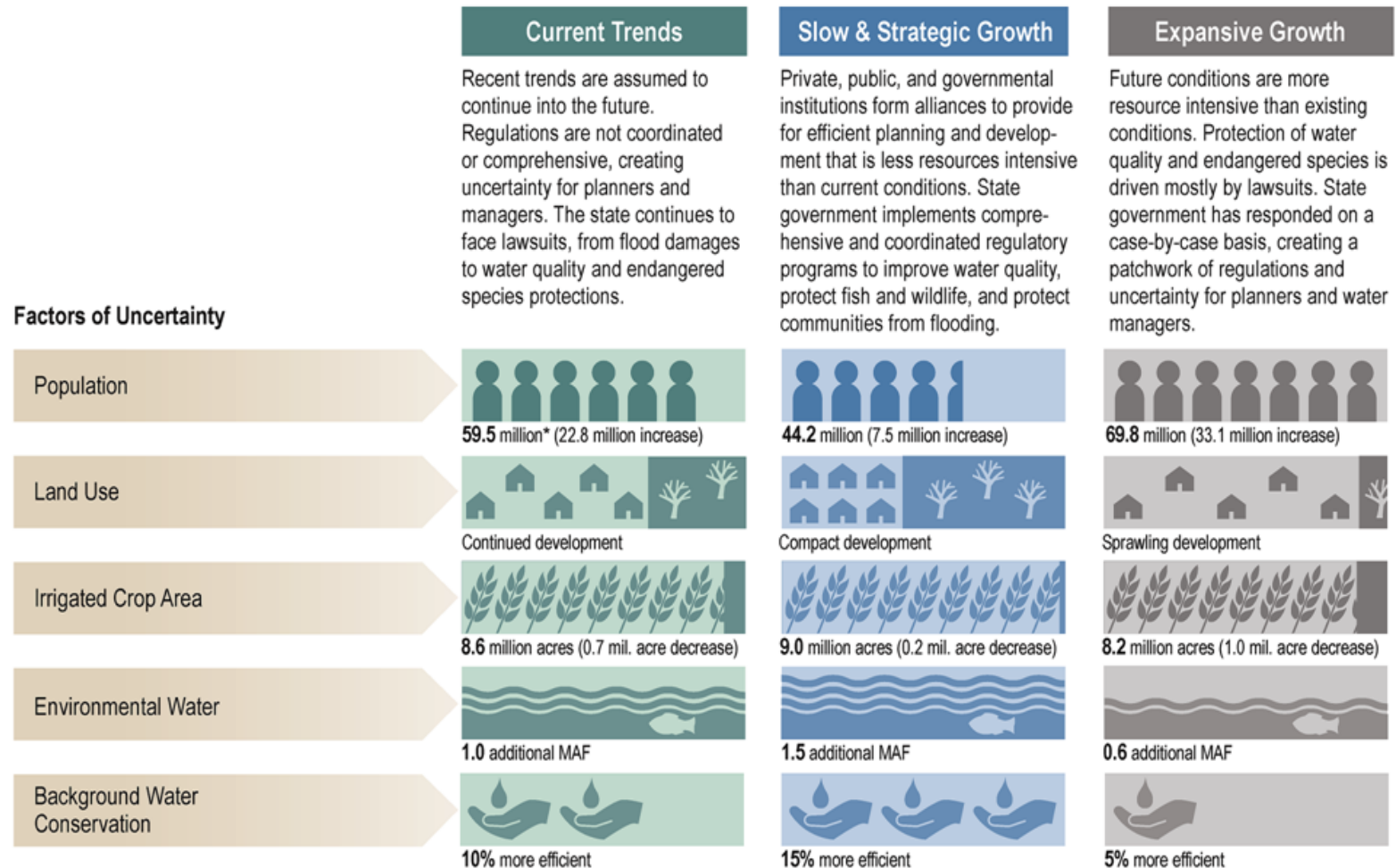
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Proof-of-Concept Evaluated Three Demographic and Land Use Scenarios ...

Factors of Uncertainty

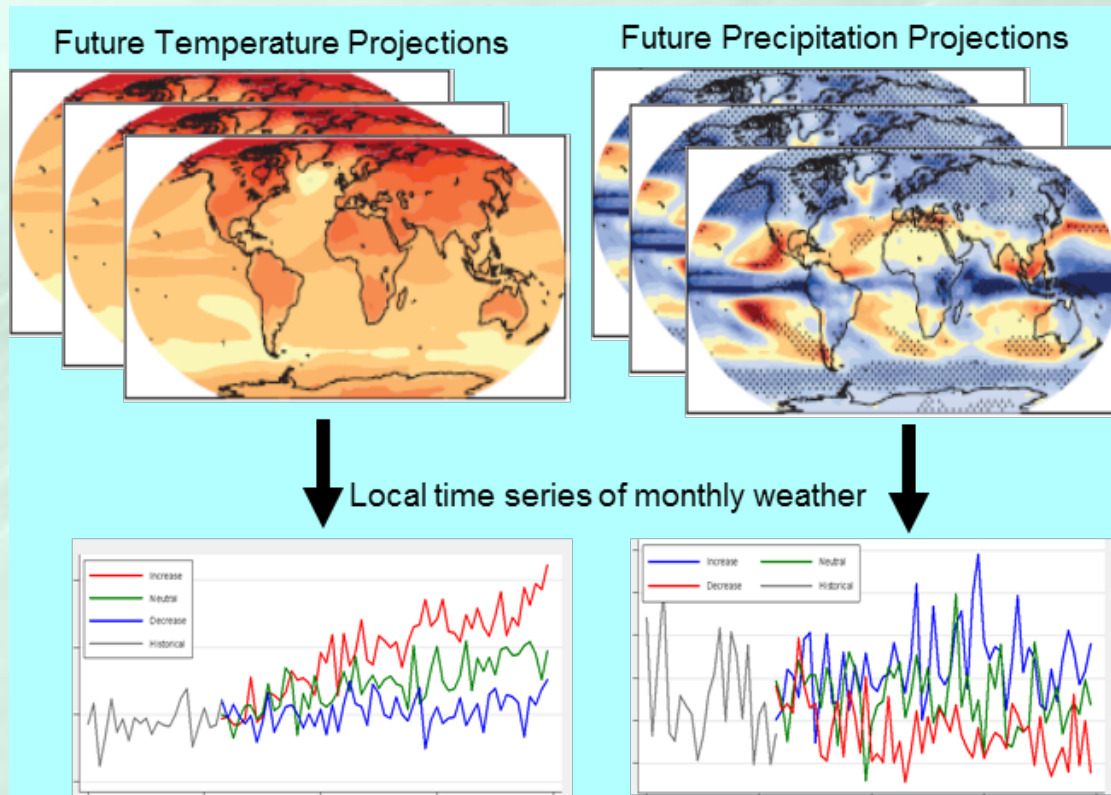


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... and 12 Climate Scenarios

Downscaled AOGCM climate sequences



6 AOCGMs

- CNRM-CM3
- GFDL-CM21
- Micro32med
- MPI-ECHAM5
- NCAR-CCSM3
- NCAR-PCM1

Two emissions scenarios

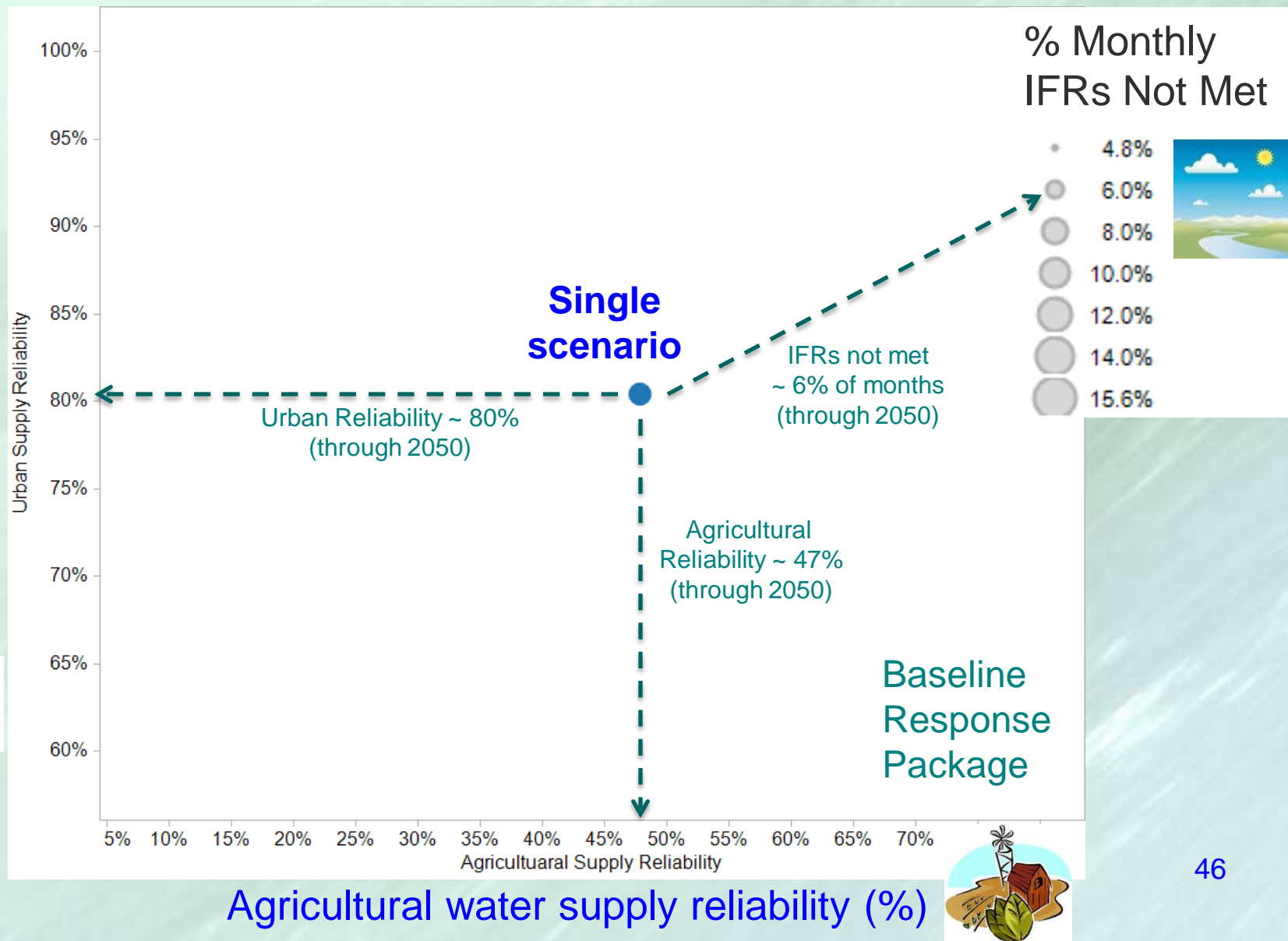
- A2
- B1

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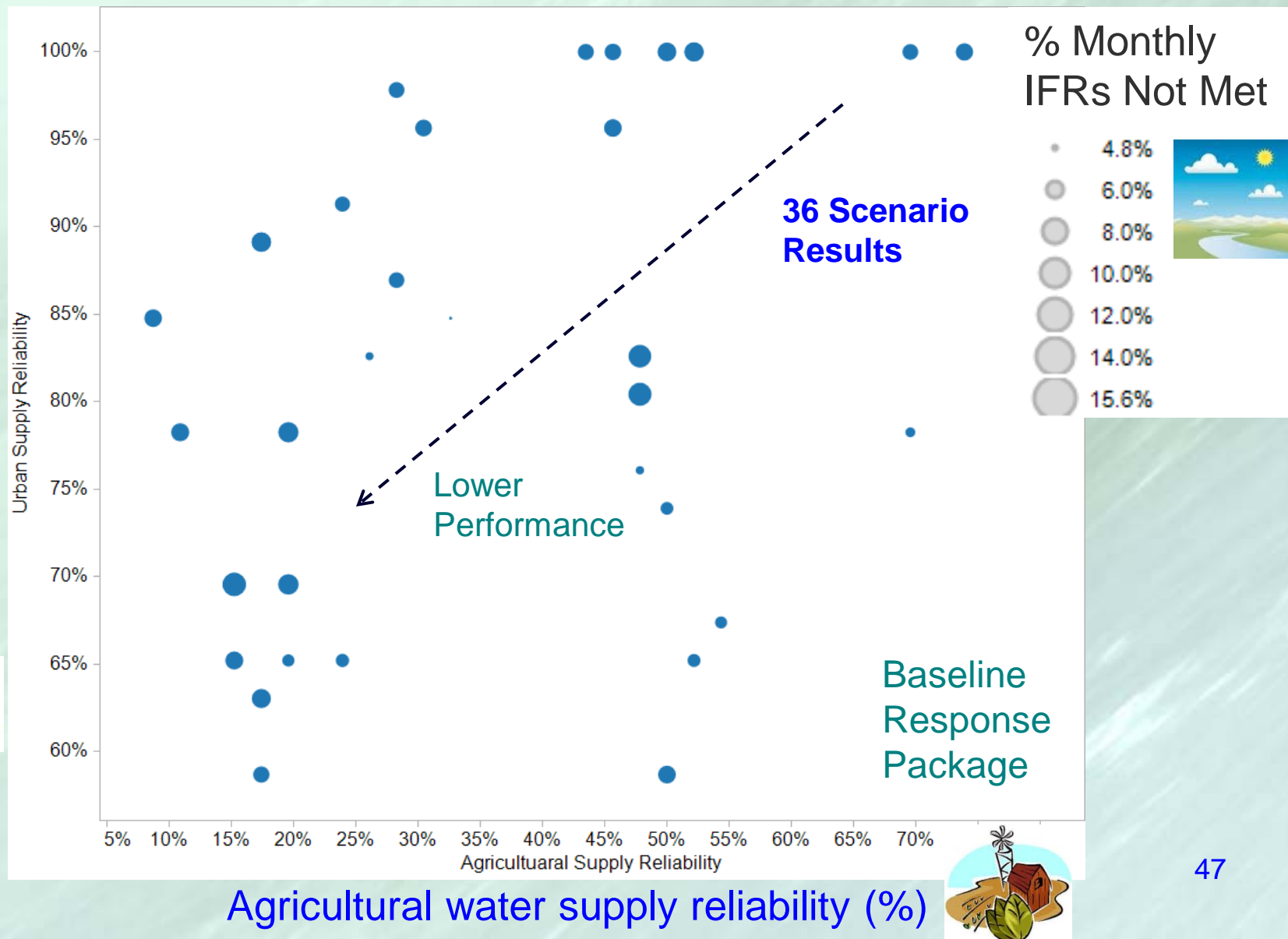
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Proof-of-Concept Analysis Demonstrates How Uncertainty Affects Outcomes



Proof-of-Concept Analysis Demonstrates How Uncertainty Affects Outcomes

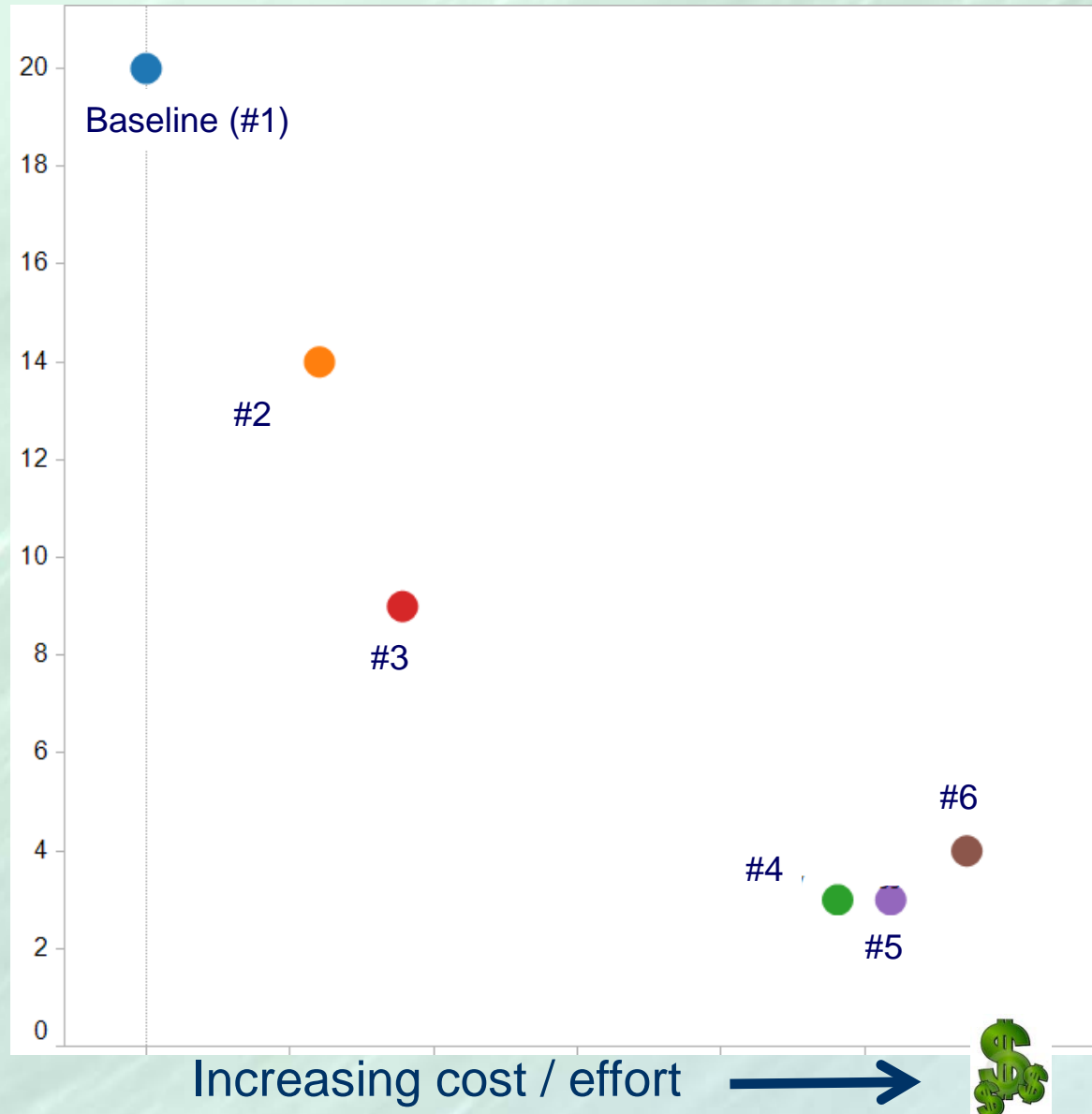


Climate Trends Define “*Hot and Dry*” Vulnerable Scenario



Implementing Additional Strategies Reduces Vulnerability to Climate Uncertainty

Decreasing number of scenarios in which performance is unsatisfactory



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Discussion Questions

- 💧 How many future population scenarios are sufficient to characterize uncertainty surrounding future population growth?
- 💧 What information about future climate change would help you make decisions when evaluating alternative resource management strategies?



Next Steps

- Incorporate workshop input into Update 2013 assumptions and analytical approach for evaluating future scenarios.
- Identify IRWM Regional Water Management Groups (find volunteers) in Sacramento River, San Joaquin River, and Tulare Lake Hydrologic Regions to offer regional resource management strategies (response packages)
- Conduct WEAP simulations using an iterative process with RWMGs.
- Present interim results to SWAN and other Update 2013 venues.



Schedule

- 💧 Fall 2011 – regional outreach
- 💧 Fall/Winter 2011/2012 – Implement proof of concept
- 💧 2012 – Scenario refinement and outreach
- 💧 2013 – Complete Scenarios



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SWAN - <http://www.waterplan.water.ca.gov/swan>

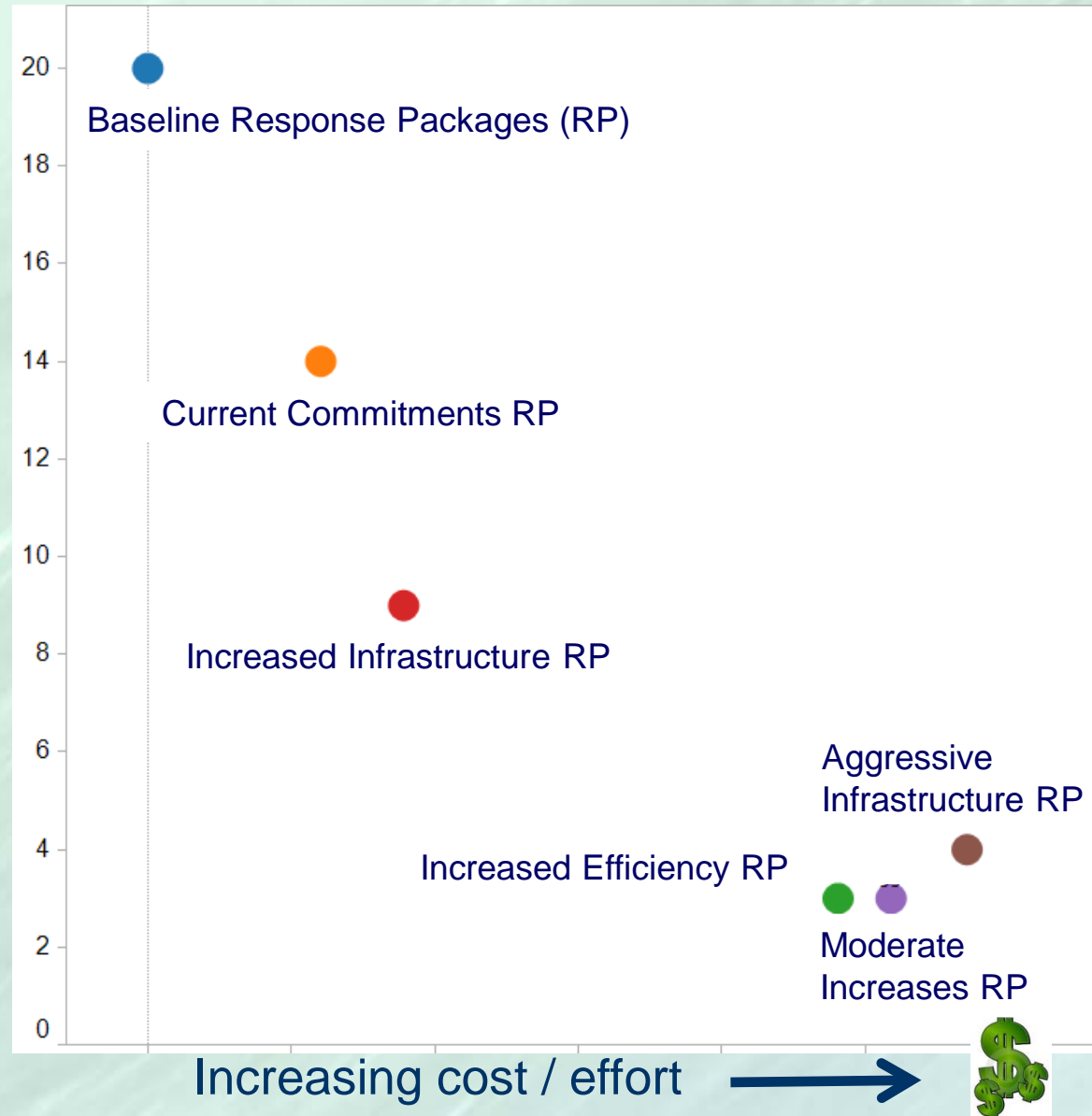
Proof-of-Concept Analysis Grouped Some Strategies into Response Packages

← Strategies →

Response Package	Urban Water Use Efficiency	Agricultural Water Use Efficiency	Groundwater Banking	Recycled Water Use
Baseline	0% Decrease in Urban Demand	0% Decrease in Ag. Demand	None	0%
1) Current Commitment	20%	0%	None	10%
2) Increased Infrastructure	20%	0%	Low Recharge	25%
3) Increased Efficiency	30%	6%	None	10%
4) Moderate Increases	30%	6%	Low Recharge	25%
5) Aggressive Infrastructure	30%	6%	High Recharge	50%
6) Aggressive Increases	40%	12%	High Recharge	50%

Implementing Additional Strategies Reduces Vulnerability to Climate Uncertainty

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